

**bart
impact
program**

**THE BAY AREA RAPID TRANSIT SYSTEM:
CURRENT STATUS AND IMPACTS**



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The BART Impact Program is a comprehensive, policy-oriented study and evaluation of the impacts of the San Francisco Bay Area's new rapid transit system (BART).

The program is being conducted by the Metropolitan Transportation Commission, a nine-county regional agency established by state law in 1970.

The program is financed by the U. S. Department of Transportation, the U. S. Department of Housing and Urban Development, the National Science Foundation, and the California Department of Transportation. Management of the Federally-funded portion of the program is vested in the U. S. Department of Transportation.

The BART Impact Program covers the entire range of potential rapid transit impacts, including impacts on traffic flow, travel behavior, land use and urban development, the environment, the regional economy, social institutions and life styles, and public policy. The incidence of these impacts on population groups, local areas, and economic sectors will be measured and analyzed. The benefits of BART, and their distribution, will be weighed against the negative impacts and costs of the system in an objective evaluation of the contribution that the rapid transit investment makes toward meeting the needs and objectives of this metropolitan area and all of its people.

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BART IMPACT PROGRAM

THE BAY AREA RAPID TRANSIT SYSTEM - CURRENT STATUS AND IMPACTS



AUGUST 1975

WORKING PAPER

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PREPARED BY PAUL BAY AND JOEL MARKOWITZ
OF THE METROPOLITAN TRANSPORTATION COMMISSION OF THE SAN FRANCISCO BAY AREA
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PREFACE

This report was prepared for presentation at the Forty-Fifth Annual Meeting of the Institute of Traffic Engineering, in Seattle, Washington, on August 20, 1975. The viewpoints expressed here are exclusively those of the authors, and not necessarily the conclusions or policies of the BART Impact Program, its Federal sponsors, the Metropolitan Transportation Commission, or the Bay Area Rapid Transit District. We alone are responsible for this paper and its judgements.



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BAY AREA RAPID TRANSIT SYSTEM --
CURRENT
STATUS AND IMPACTS

I. BACKGROUND

BART, the San Francisco Bay Area Rapid Transit System, has long been one of the most highly visible public investment projects in the region. Constantly in the spotlight for nearly two decades, BART has generated discussion and debate along the continuum from adoration to defamation. BART's most ardent champions have painted a picture of a savior in steel to rescue the region from all its urban ills:

BART will save the downtowns from deterioration

BART will concentrate development to preserve open space

BART will reduce dependence on automobiles

BART will reduce air pollution by reducing traffic
congestion

BART will save energy resources

BART will provide new mobility opportunities for the
disadvantaged

BART's equally vehement critics have concentrated on other aspects:

BART costs too much

BART cannot overcome its own serious technological problems

BART was designed to serve only the high-income, white-
collar suburbs

BART provides a new "escape route" for the middle class
to leave the cities

BART forces low-income residents to pay higher rents or
move due to BART-induced property appreciation

Somewhere between are BART's apologists, who view the system as the hapless victim of inflation, political manipulation and a fickle public.

In this context, we cannot plunge ahead, speaking broadly of BART's "impacts" without first exploring in more detail the complex history of this unusual undertaking, its initial goals and its current operating status.

A. Initial Goals and Basic Design Decisions

The earliest statements about BART by the study commission which led to formation of the BART District (1951-56) carried two basic directions which remain today foremost in both the official and popular concepts of BART's purpose. First is that the level of service BART provides will rival the automobile in comfort, speed and convenience, and thereby "lure" motorists onto rapid transit, reducing the general level of traffic congestion and its attendant ills. Objectives of reducing automobile-generated air pollution and reducing energy consumption are more modern additions to this basic goal. The second major purpose was to design the routes to serve the historic growth patterns of the region, to strengthen the existing downtowns, and to mitigate urban sprawl by placing suburban stations to encourage concentrated commercial development. More recent goals to also concentrate residential development near stations were not integral to the early BART plans. Rather, BART's originators wanted to facilitate the growing pursuit of the suburban lifestyle by reducing the penalties of long-distance commuting.

The goal of openly competing with the automobile led to several kinds of key decisions. Design of the car interiors to include carpeting, upholstered seats and full climate control was certainly an early direction agreed upon by both designers and politicians. Standards for ride quality included the use of continuously welded steel rails to offer a smooth, quiet ride. Basic operating characteristics like the top speed of 80 mph and peak headways of as little as 90 seconds, as well as the promise of efficiency through full automation, were all set with a clear eye to the competition.

The Bay Area's unique "doughnut" topography and its development history largely determined BART's basic routing. The political decision to maintain the viability of both major central cities (Oakland as well as San Francisco) resulted in all East Bay lines providing direct service to downtown Oakland as well as crossing the Bay. Some BART critics have even offered a "conspiracy theory" to explain BART's focus on the downtowns: a small group of the leaders of "big business" invented the BART idea to maintain their concentration of economic power downtown in the face of suburbanization trends, while selling the idea to the public clothed in popular issues of the day like traffic congestion relief.

Station spacing was a function of two criteria. First was the desire to serve or reinforce existing city centers, other regional sub-centers and major public facilities. Second was the need to maintain a high overall system speed (40-45 mph). Visitors to BART are often surprised to find what is essentially a commuter railroad with long lines and widely-spaced stations, instead of a New York or Boston style subway system of interlocking cross-town lines and frequent stops.

The decision to serve the existing growth patterns, coupled with the desire to minimize the economic and political costs of community disruption, led to routing along existing rights-of-way and to joint construction with a new highway to allow BART to occupy the median.

Two special design features of BART were added on after the 1962 bond vote. A 1968 Legislative enactment required that all public facilities be designed for access by the physically handicapped. BART responded with an \$8+ million program to install elevators in stations. While there have been some problems in use of the elevators, due to their awkward placement in many stations, the major problem remains the inability of the handicapped to use public transit to access the BART stations and the limited number of desired destination cities that have instituted curb-cut or ramp programs to facilitate use of wheelchairs. The other prominent add-on came from the 1966 grant by the U. S. Department of Housing and Urban Development for an Urban Beautification Demonstration Project to create a linear parkway beneath BART's aerial structure in the cities of Albany and El Cerrito. The 2.7-mile parkway, just north of Berkeley, has won several urban design awards and is one of the most attractive showcase elements in the system.

The general acceptance of BART routing and station placement as presented before the 1962 bond vote began to fade as the lines on the maps came closer to concrete and steel reality. By the time the final design was underway, the local politicians who had approved the early BART plans were no longer in office or were having second thoughts on their earlier judgments. BART's planners and designers, along with the local officials, ran up against a rising tide of public activism in the Bay Area in the mid-1960's. A highly sophisticated and politicized citizenry in that era mounted several vigorous and successful campaigns that affected BART by setting a general tone of "the people vs. the bureaucracies." Groups in San Francisco organized around the planned cross-town and circumferential Interstate highways which were to link the Golden Gate and Bay Bridges, and provide for movement of through traffic on U.S. 101 across the City. All plans were blocked by the "freeway revolt," and the legacy of partially-built, elevated freeway structures ending in dead-end stumps, remains an unusual element in San Francisco's landscape. Concern over preservation of open views of, and access to, the Bay and surrounding hills produced a running battle between conservation and development interests, leading to the formation in 1965 of a special commission to control all development along the Bay. Similar battles occurred whenever large-scale developments were proposed which seemed to threaten a widely held, but generally unarticulated, aesthetic standard. One of the most frequent pejorative labels attached to any such threatening project was its "Manhattanizing influence" on the Bay Area. BART was often thrown into this general Man-

hattanizing category, and this analogy kept BART design and construction under close scrutiny throughout that period. As a result, 15 miles of the 71-mile system were re-routed, and 16 of the 34 stations were relocated, including addition of an entirely new, \$26 million station in downtown San Francisco.

B. Financial/Political/Institutional History

With the foregoing to set the stage from the physical design standpoint, the unique political and institutional factors which have heavily influenced the shape BART has taken need to be considered.

Perhaps the most important single factor is the dependence of BART on local funding. A local property tax and a half-cent sales tax in the three BART District counties support the bonds that provided 60% of BART's capital costs of \$1.6 Billion. Bonds based on the tolls from transbay bridges account for another 11%, and other local sources for approximately 8%. Thus 80% of BART's total capital costs come out of local pockets. Politicians and taxpayers are keenly aware of this fact, and there is a recurring theme of who pays vs. who benefits from many BART critics. Substantial portions of the counties in the BART District are many miles from the transit stations. Much of this "non-service" area is of a low-density, geographically dispersed character that would be difficult to serve by rail rapid transit. However, BART has recently inaugurated its own express feeder bus service from some of those outer areas to nearby BART stations. Aside from not offering full coverage to District taxpayers, one station, Daly City, is used almost exclusively by residents from outside the District who pay no direct BART taxes. There is also the consistent accusation that central city residents are being taxed to subsidize suburban commuters. Arguments the BART will help take suburban commuters' cars off central city streets have not been uniformly persuasive. Due in large part to this dependence on local taxpayers and highly visible forms of taxation, there has often been only a rather grudging acceptance of BART.

Another important factor is the limited jurisdiction, both geographical and functional, of the BART District. While early plans envisioned a rail system which would eventually circle the Bay, from north of San Francisco down to San Jose, the District formed in 1957 included only five of the total nine counties in the region. Of these, two withdrew shortly before the 1962 bond vote, due primarily to questions of their ability to support construction costs from their local tax bases. This truncated version of the BART District includes approximately one-half of the Bay Area's total population of 4.8 million.

Further, the complex fabric of overlapping and often competing jurisdictions has prevented the emergence of a cohesive regional transit system. Since BART is empowered only to build and operate the rail rapid transit lines (BART considers its new express bus feeders to be extensions of the trunkline), it has no direct control over the local bus service that acts as the feeder/distribution system for its stations. Local bus service in the BART service area is the responsibility of two separate agencies, the San Francisco Municipal Railway (Muni) in the City and County of San Francisco, and the Alameda-Contra Costa Counties Transit District (A-C Transit) in the two East Bay BART counties. Years of technical studies and delicate negotiations were required before either of the two local operators could reach agreement with BART on realigning routes to serve stations, dropping runs directly parallel to BART, and initiating transfer arrangements. Even now, Muni and A-C each have a different BART transfer system, and there is no uniform joint fare or transfer system among the three operators. This difficult situation is a direct result of the general transit finance picture, where each operator is facing rising costs, falling revenues, and allegiance to taxpayers only within its own jurisdiction.

C. Current BART Operations

From the ground-breaking in 1964, eight years passed before the first BART trains began regular revenue service. Even then, in September of 1972, only the segment from Oakland to Fremont was operating. Three other lines (Richmond, Concord and Daly City) were opened during 1973, with the final link, the transbay tube between Oakland and San Francisco, beginning service in October 1974.

With all lines formally open, BART service is still partial in many respects. There is no direct service between the Richmond line (north of Oakland) and San Francisco. Passengers on that line must transfer at an Oakland station to one of the two lines on which trains operate directly transbay. This situation is due to both an inadequate supply of reliable rolling stock and an extensive program to modify the automatic train control and back-up systems, required of BART by the California Public Utilities Commission.

BART currently operates weekdays only, from 6 AM to 8 PM on 12-minute headways. The full-service goal of seven-day, 6 AM to 2 AM operations with 6-minute headways is not yet within sight. This, too, is a function of the unreliability of the vehicles. BART is able to keep only slightly over 50% of its cars in service during daily operations, and it must use its mainline tracks for vehicle testing in the evening hours and on weekends. The outcome of BART's current suits against its principal equipment suppliers is uncertain. BART's technological

difficulties have been attributed to many factors, but certainly one of the most significant is that BART and its designers firmly believed they could engage in basic research and development while at the same time constructing a production system. The promise of "modernity" back-fired, as the political pressure (fueled by the concerns of the local taxpayers) to open the system won out over the need to subject the untried equipment to more rigorous field testing. Critics charge both overpromising the technology by BART and poor design of major components by BART's contractors. While the present legal actions may formally establish culpability, the real effect has been to offer to the public a level of service far below the promises and expectations of earlier years. Consequently the current patronage is substantially below earlier "full-service" projections.

Twenty-two BART stations have parking facilities for from 240 to 1400 vehicles, for a system total of over 18,000. The Daly City station parking facility, heavily used since service there began in 1973, is being expanded from 900 to 1700. Supplemental parking on temporary lots is being added near some stations on the Concord and Fremont lines where present facilities are completely filled by early morning commuters, thus discouraging midday trips. Systemwide, parking facilities are 80% full.

The access constraints of limited suburban parking and little public transit in the fringe areas have possibly served as a general brake on BART patronage growth. Another factor limiting patronage may be the effects of the widely publicized BART mishaps. Shortly after the 1972 opening, an electronic component to control train speed failed and sent a train accelerating past the end station on the Fremont line, dumping the car on end into a sand pile. While there were no serious passenger injuries, the event served notice that BART might not be quite ready for full-service operation. Later, a BART worker was hit by a train in the BART yards and killed. In 1975, another accident involving a BART train and a track maintenance vehicle during non-revenue service hours caused the death of another BART employee. Finally, an improperly set brake let an unoccupied BART car from a siding roll through several stations before coming to a halt, with no injuries to patrons or employees. In all cases, BART has responded by further tightening safety and maintenance standards. Overall, BART's safety record is equal or superior to that of any other transit system. Yet the image of BART, based on bright promises and high expectations, has been tarnished.

D. Comparisons to Other Systems

It is useful to keep in mind the differences between this BART history and the experiences in three other areas now actively engaged in the design or construction of "BART-like" systems.

In Baltimore, Atlanta and Washington, D. C., the builders and operators of the rapid transit system are also the sole operators of the regional bus system. This not only facilitates the eventual full coordination of feeder/distribution service and joint fare and transfer arrangements by eliminating jurisdictional problems, but provides the priceless political advantage of being able to offer improved transit service to area taxpayers during rapid transit construction. The financing of all three systems is planned to be from two-thirds to four-fifths Federal, and the visible, direct burden on the local pocketbook is thus considerably lightened. In the case of Baltimore, the "local" share of funds is from statewide general revenues (including gasoline tax receipts), thus further insulating that system from possible local political friction.

The three systems also have benefited by the design experience of BART, and have kept a careful eye on BART's technological difficulties. Baltimore has opted for a more conventional technology for its Phase I system, while Atlanta and Washington have taken on a very "BART-like" shape. They are all counting on BART's having absorbed the initial "R&D" costs of evolving a modern rail technology.

Finally, the basic design differences among the systems may be summarized by looking at the number of stations and miles of track in each:

	<u>MTA</u> <u>(Balt.)</u>	<u>MARTA</u> <u>(Atlanta)</u>	<u>METRO</u> <u>(Wash.)</u>	<u>BART</u>
Track miles	28	53	98	71
Stations	21	39	86	34
Construction period	1974-81	1975-80	1969-79	1964-74
Capital cost (approx.)	\$1 B	\$2.1 B	\$4.5 B	\$1.6 B
Ratio: miles/stations	1.33	1.36	1.14	2.09

The ratio of miles/stations is an admittedly gross indicator of station spacing, without any correction for differences among the respective service areas. Even so, it is clear that the kind of service BART offers the Bay Area differs significantly from that promised by the other systems under construction.

II. IMPACTS

A. Coming to Terms with "Impacts"

At long last, we come to the central subject of BART's impacts.

But first, we should lay some groundwork on just what we mean when we speak of impact analysis.

The very use of the term "impacts" implies a direct causal mechanism through which an action (in this case, building and operating BART) affects some or possibly all other elements of the metropolitan region. What is the nature of such a mechanism? There is no single, accepted theoretical representation for the complex and dynamic interactions which motivate daily life in urban America. Instead, we are thrown back on an eclectic tool kit of economic theory, behavioral theory, planning concepts and empirical experience. Thus, our first presumption in impact analysis is humility. We know we can't look at everything simultaneously, even if we knew precisely what to look for. With no unified theoretical basis as a defense, we must rely on an iterative process of searching, measuring, interpreting and redirecting when the searches lead to blind alleys. No grand scheme here, but only the careful selection and application of proven tools.

We can describe an impact along many dimensions, all of them necessary for a full understanding of the phenomenon. We must know the magnitude of the impact (how much of a change was caused?), the incidence of the impact (where and on whom was the impact felt?), and the time-scale of the impact (is it long-term or short-term in occurring, temporary or permanent in effect?). Other dimensions are possible, but the important concept is that there is no facile definition of impacts.

Once we have isolated an area of possible impact and identified its dimensions, we have only begun the serious methodological work of measuring the beast. Few would propose that a classical experimental design with well-defined and mutually exclusive control groups could ever be applied in a "real world" situation. Studying changes in trends in traffic volumes, or comparisons between "similar" areas within and beyond BART's service area are subject to several complications. For example, a simple but effective criticism of control groups or areas is that they are often quite different from the experimental group or area in important but overlooked ways. More likely, even if the two "similar" groups are identical initially, they might well change significantly during the time a multi-year evaluation program is being conducted. Since the motivating factors in modal choice are many, and the proposed theories relating the factors are equally numerous, it would take an unusually firm faith to declare unswervingly that all relevant control factors are completely accounted for in the initial selection of study groups and areas.

The concept of confounding or exogenous variables is one of the most troublesome of these complications in impact analysis. We have the problem not only of detecting change in, say, traffic congestion due to BART, but we must account for any other

variables possibly affecting traffic congestion at the same time. In this example, we have the coincidence of BART's opening with a dramatic increase in gasoline prices, and also with some new changes to highway service, like the metering system on the Bay Bridge and preferential treatment for buses and car pools through the toll plaza during the peak. Measuring BART's impacts in this case by a simple before/after, with/without comparison would quickly suffer from the erroneous presumption that any change detected between the two observations was due primarily to BART alone.

Another issue is the incremental nature of BART's service. A long learning curve has been built into any traveler response to BART due to its phased introduction of service and its very gradual move toward full service, at a yet unknown future date. It is difficult enough to control for exogenous variables surrounding a well-defined, one-time event, but extend that event over three of four years and the difficulty verges on impossibility.

The fact that BART was fully intended to serve existing growth patterns doesn't help the analyst, either. By being firmly embedded within heavily-traveled and well-established transportation corridors, BART cannot be expected to produce radical changes in travel. Finally, we must assume that the 71-mile BART system can only serve a very small absolute number of trips relative to the service now provided by the ubiquitous system of over 6000 miles of city streets, county roads and highways in the BART District counties. Not only is the needle small and the haystack large, but the wind does blow strong!

The classical theoretical assumption of all other things being equal is thus so far from the truth that it must be discarded. Instead, we must rely on an assortment of so-called quasi-experimental designs, each of which carries its own cautions in application. A combination of approaches, looking at control groups, control areas, points along a time continuum and overall trends, must be pursued in parallel to try to prevent our elusive prey from slipping through our admittedly flimsy methodological net.

With these unrelentingly discouraging words, why then should we pursue this impact analysis? The motivating factor is the immediate need to advise BART, its friends and critics, other metropolitan areas building or contemplating rapid transit systems and the State and Federal governments on the effects, both intended and unplanned, of a major public investment in rail rapid transit. Billions of future dollars are at stake, yet there is now no firm, factual basis for offering recommendations for imminent policy decisions on public transit. Along the way, we might also make a contribution to the methods of measuring and interpreting impacts. These are, in most general terms, the goals of the BART Impact Program, conducted by the Metropolitan Transportation Commission, under the sponsorship of the U. S. Department of Transportation and U. S.

Department of Housing and Urban Development. The findings to date, reported below, are from that program.

B. Impacts of BART to Date on Travel Behavior

The BART Impact Program will be exploring BART's impacts on the natural environment, on land use and the large-scale pattern of urban development, on regional economics and public finance, on cultural institutions and life-styles, and on public decision-making, as well as the most direct impacts on travel behavior and the regional transportation system. It is the latter category of impacts which will concern us here. Our focus on only this one area is based on two assumptions. First, BART's other impacts may be of a long-term nature, and therefore may not be detectable during this interim phase of partial BART operations. Second, our ability to detect the presumably direct changes in travel behavior and traffic may yield an early indication of our ability to eventually assess changes in the other more complex and indirect impact areas.

Rather than starting from historical trends in total regional travel and trying to infer BART-induced changes, we will turn instead to a consideration of BART itself. Then, we may more clearly define what impacts we might expect, given the observed levels of BART service and patronage.

1. BART Patronage

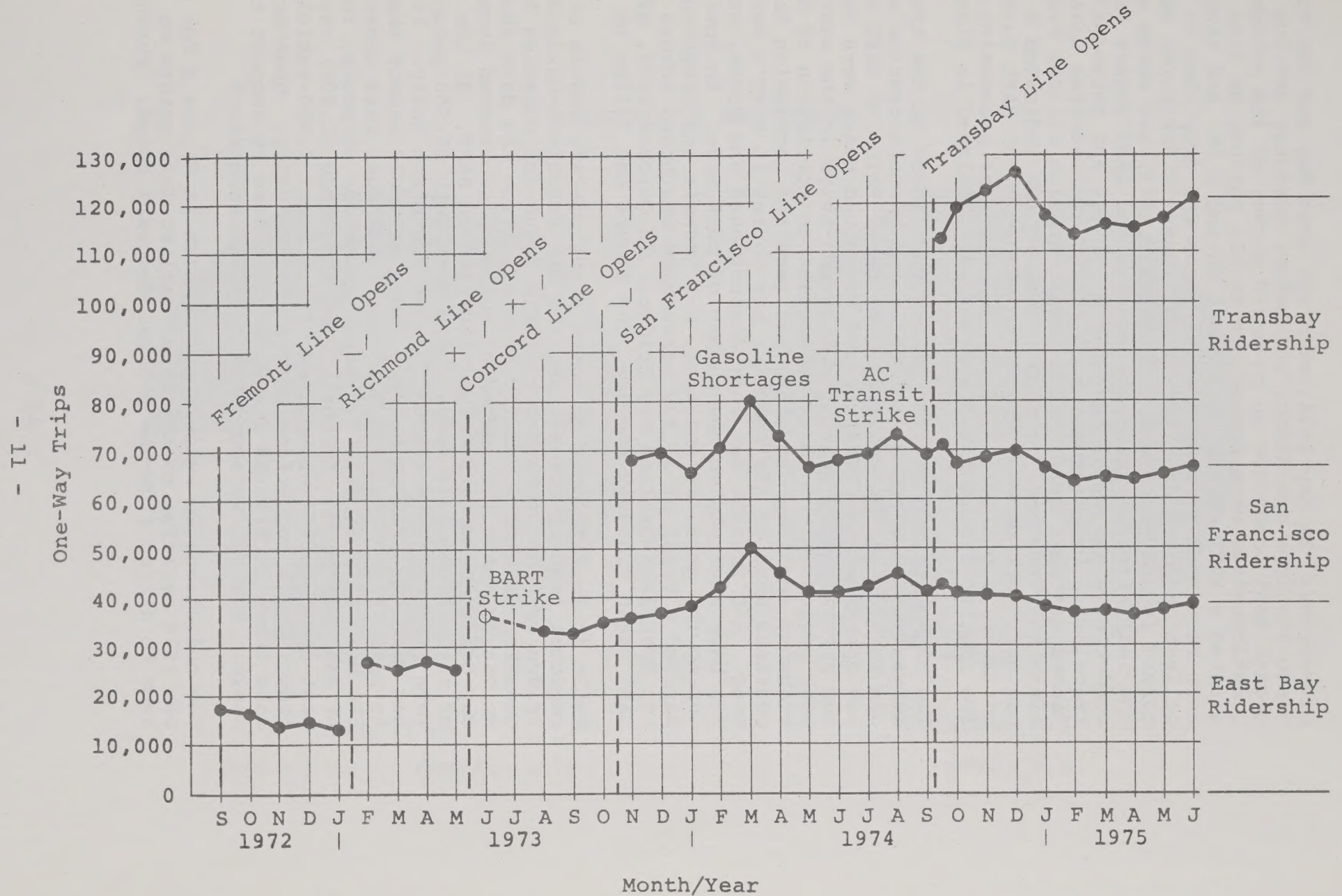
Figure 1 shows the pattern of daily BART patronage since its opening in 1972. The average one-way person-trips are shown by (a) trips made only within the East Bay, (b) trips made within San Francisco (including Daly City), and (c) transbay trips. There is a remarkable stability in each of the three categories. Only three special cases caused short-term peaking above the flat trend. First was the gasoline shortage in February-April 1974, when there was a general surge in transit usage nationwide. Second was the two-month strike by A-C Transit drivers July-August 1974, which indicated that BART was an alternative mode for some regular bus riders. Finally, the extension of BART operating hours until 10 PM during the Christmas 1974 shopping season (Thanksgiving to Christmas Eve) allowed shoppers easy access to downtown San Francisco's many large department stores and specialty shops, without the usual problems of traffic and parking costs. The stable patronage may suggest that some ceiling has been reached, which cannot be pierced without some further reduction in system capacity constraints (e.g., train availability, equipment reliability, parking and access, etc.).

2. From What Modes Have BART Riders Been Diverted?

Two surveys of BART riders offer an indication of mode

Figure 1

AVERAGE DAILY BART RIDERSHIP, SEPTEMBER 1972 - JUNE 1975



diversions. In May 1974, with all East Bay and San Francisco stations operating, but before transbay service began, BART conducted an on-board survey of its patrons. Questionnaires were handed out to all patrons as they entered a BART station between 6 AM and 1 PM, and they were requested to complete the forms and drop them in collection boxes as they exited. Over 17,000 forms were turned in and processed. In October 1974, six weeks after the initiation of transbay service, the BART Impact Program conducted a survey of transbay BART, bus and automobile travelers. Pre-stamped, mail-back questionnaires were handed out to a sample of patrons entering all San Francisco BART stations, but only those which indicated a transbay trip were processed. Of more than 7,000 BART forms returned, 2,000 were randomly selected for processing. The results from the two surveys are displayed in Figure 2.

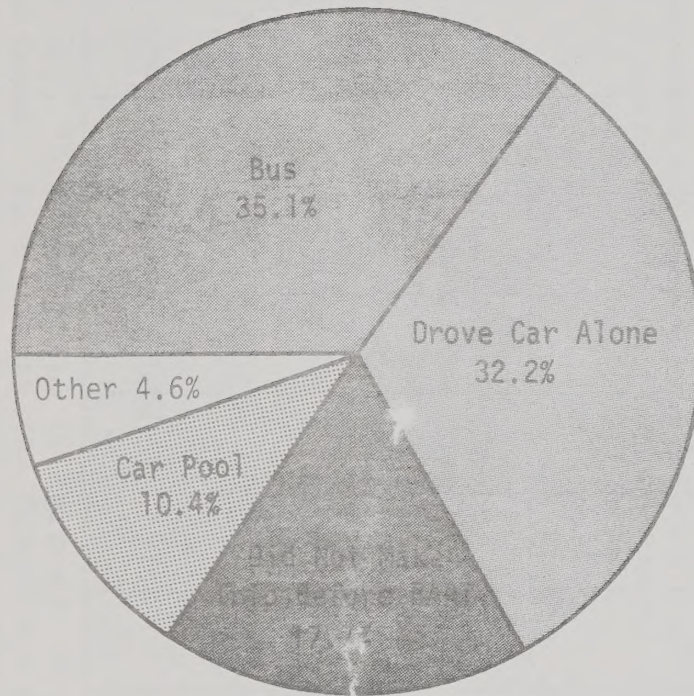
The higher percentage for former bus riders in the transbay survey reflects the historically heavy concentration of bus service in the transbay corridor. Prior to BART transbay operation, A-C Transit and Greyhound buses were carrying approximately half of all person-trips in the week-day peak period (6 - 9 AM). Subsequent to initiation of BART's transbay service, Greyhound has received permission to discontinue most of its commuter bus routes in BART's service area. A-C Transit has only discontinued one route, but has cut back severely on the number of runs made. In April 1974, during the gasoline shortage, A-C Transit and Greyhound carried a total of 33,472 passengers westbound across the San Francisco-Oakland Bay Bridge. In October 1974, after BART began transbay service, the figure had fallen to 19,252.

While it is difficult to speak about overall levels of regional traffic congestion, the San Francisco-Oakland Bay Bridge corridor provides a single focus for pursuing our question of BART's traffic impacts. From the data above, we can estimate the number of automobiles removed from the Bay Bridge by motorists who diverted to BART. At the time of the October 1974 survey, approximately 25,000 persons were riding BART westbound to San Francisco daily. If 27% had made the trip as drivers, then we would expect there to be 6,750 ($25,000 \times 0.27$) fewer passenger cars crossing the bridge. Assuming 2.5 persons/car for carpools, the 8% of BART riders who formerly used that mode (2,000) represent another 800 automobiles, for a total 7,550-vehicle reduction in Bay Bridge traffic volume daily. However, data shown in Figures 3 and 4 do not seem to support that claim. How can we account for this discrepancy?

The reductions in vehicle trips shown in Figure 3 for October 1974 relative to the three earlier data points do not seem to differ from the general downward trend. Further,

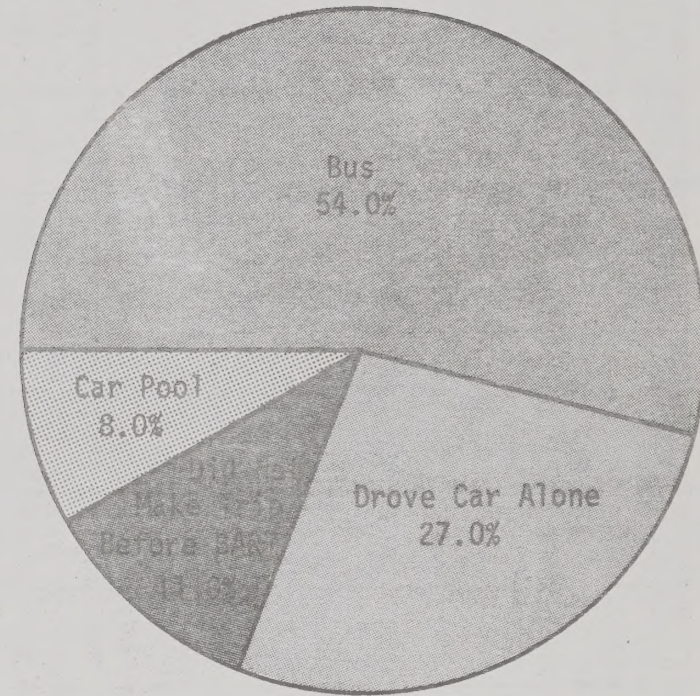
Figure 2

PRIOR MODE OF BART PATRONS



May 1974

East Bay and San Francisco Only

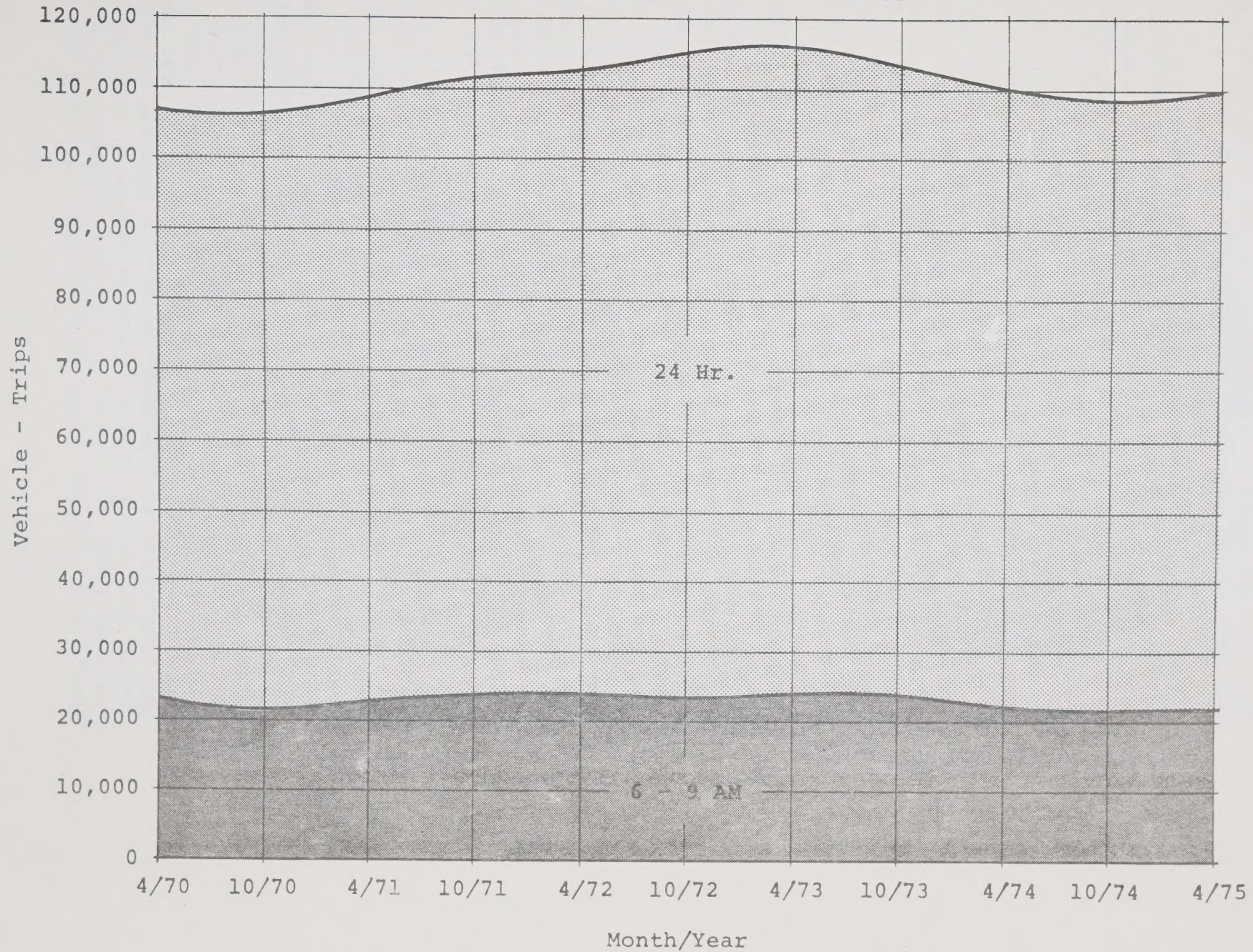


October 1974

Transbay Only

Figure 3

TOTAL VEHICLES WESTBOUND
SF-OAKLAND BAY BRIDGE
24 HR & 6 AM - 9 AM PEAK PERIOD



the comparison between the April 1974 and April 1975 counts shows virtually no change. Yet the total person-trips (Figure 4) show an impressive increase since BART's transbay opening. While we must heed our own caution not to jump to conclusions based solely on "before/after" data, the graphs do suggest that there may have been some fundamental shift in the nature of transbay travel due to BART. There have not been dramatic shifts in population or in the regional economy which could account for such a swift increase in total transbay travel. Aside from measurement errors and sampling errors, several explanations are possible.

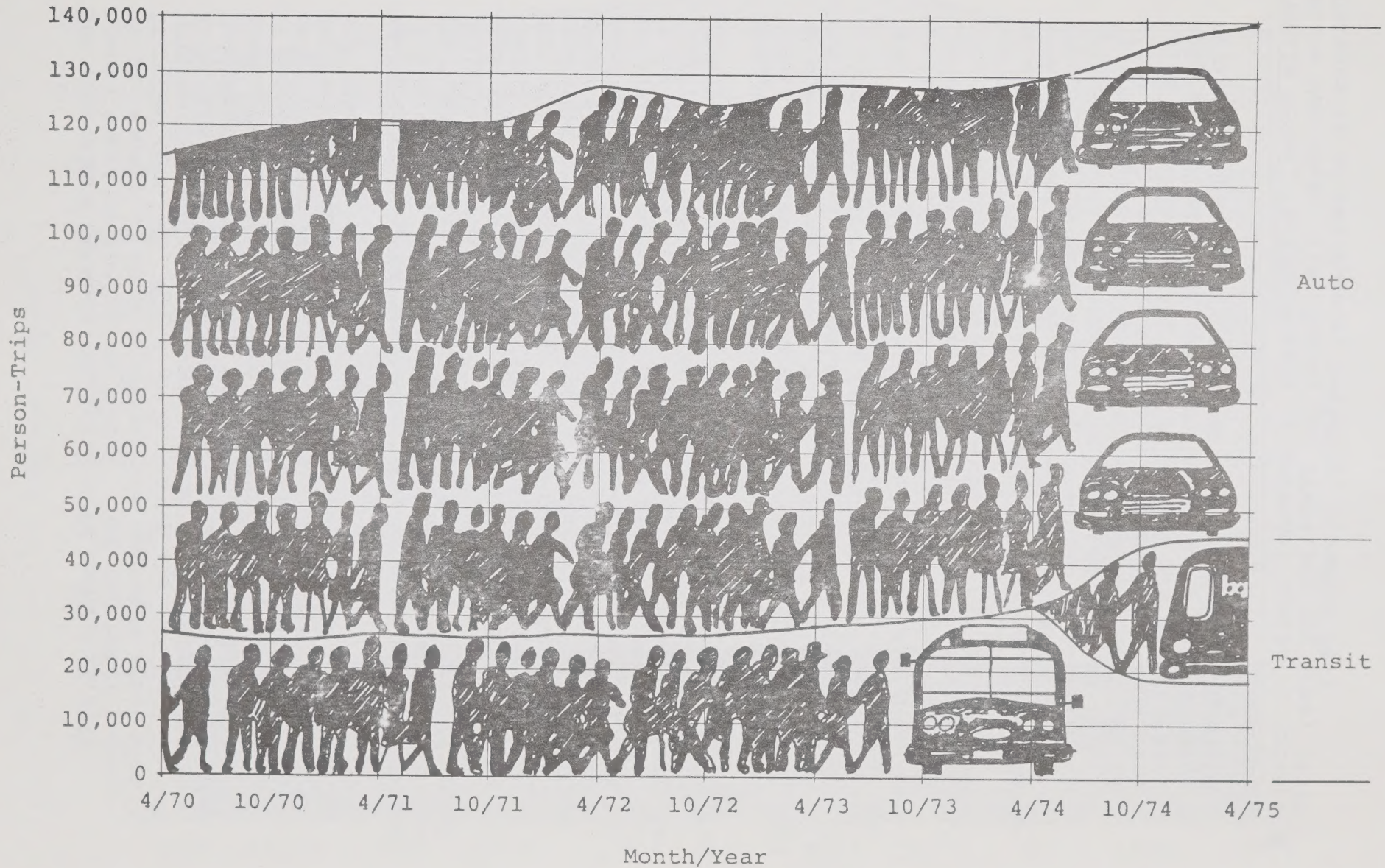
The introduction of BART's transbay service may be compared to the opening of a new highway in that there was a sudden, one-time increase in the absolute capacity in the affected transportation corridor. If the comparison is accepted, then we might also expect to see the same overall effect on travel in the BART case as we have experienced with new highway development. In many cases, this experience has been that traffic congestion is relieved for a short time after the new facility is opened, thus realizing its primary purpose, but that traffic on the new road soon builds up again, virtually restoring the previous congestion level. Newly expanded transportation facilities becoming their own traffic generators is now a well-accepted concept, even though the proof tends to be more anecdotal than scientific.

Another explanation challenges the assumption that BART riders who previously used their cars now leave them locked in the garage at home. While the survey data have not yet been examined in this light, we might propose the following scenario. It has been estimated that 26% of all household members 16 years of age and over in the East Bay BART service area lack direct, personal access to an automobile.¹ These persons are thus at the mercy of public transportation and obliging drivers to satisfy their mobility needs. It has been estimated that 57% of all adult Bay Area household members (over 16 years old) reside in households with fewer motor vehicles than adults.² Therefore, for the majority of households, there will be an improvement in their mobility situation if an exclusive user of one of the household's vehicles can now leave it at the disposal of other household members while he/she rides BART. The switch from car to BART for some households may then yield a more efficient use of the household's limited transportation resources. Rather than having the primary wage-earner, for example, taking the

1,2) Donald Foley, "Differentials in Personal Access to Household Motor Vehicles: Five-County San Francisco Bay Area, 1971", University of California, Berkeley, December 1972.

Figure 4

WESTBOUND PERSON-TRIPS
S.F. - OAKLAND BAY BRIDGE 6 AM - 8 PM
(Note total transit share increase)



family car to work and letting it sit all day, the other household members would now have the potential for expanding their personal mobility. This could range from exploring new shopping areas to enrolling in a previously inaccessible college or entering the job market. In short, the family's "new car" could very well be used to make "new" trips, and these could well be transbay trips to destinations not directly served by BART. This all leads to the interesting conclusion that the introduction of rapid transit in an automobile-oriented area could result in no net change in automobile travel at all, thus confounding hopes and predictions for a general reduction in total vehicle-miles traveled.

Yet another explanation for the increase in person-trips could be based on that category of survey respondents who reported in October 1974 that they had not made that type of transbay trip prior to BART's opening. Approximately 6% of all transbay trip-makers were in that "no prior trip" category, but 4.5% of them were in automobiles and only 1.5% on BART. Therefore, we cannot easily conclude that BART itself was the primary cause behind all these new trips. The October 1974 data have not yet been examined for clues to the nature of this phenomenon. However, the May 1974 BART survey suggested that most of BART's new-trip makers at that time were under 25 years of age, and bound for school or work. That age group is well-known for both its general job and residential mobility, and its historical attraction to San Francisco. These new trips may thus be by the young newcomers to the Bay Area. We cannot, unfortunately, hope to account for all the new trips by this simple reasoning. At present, all our explanations are tentative and partial. If nothing else, they serve to warn us that even the direct travel behavior impacts of BART may be exceptionally difficult to discern.

3. What Kinds of Persons are Using BART, and For What Purposes?

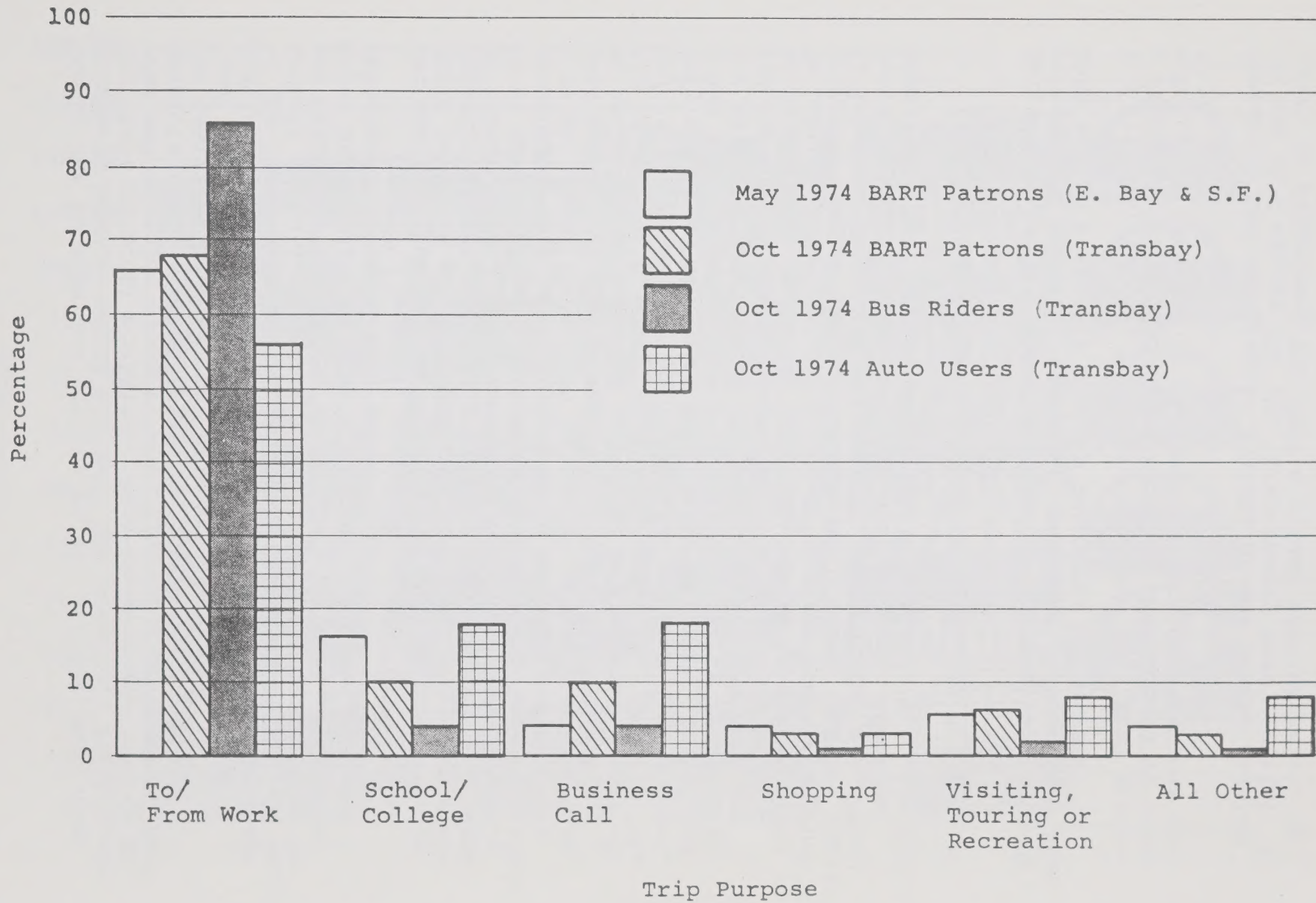
Relying again on the May and October 1974 surveys of BART patrons and transbay travelers, respectively, we find that BART serves a variety of trip purposes. (Figure 5)

For transbay travel, it should be noted that BART serves a range of trip purposes as broad as that served by automobile, in contrast to the heavily work-oriented bus service.

Comparing the demographic profile of the survey samples to the 1970 Census for the three-county BART District (with no adjustment for BART's actual service area), we

Figure 5

TRIP PURPOSES ON BART AND ALTERNATE MODES



see that BART riders appear to be a younger, better educated and more affluent group than the general population, but not unlike the transbay auto travelers (Figure 6).

Transbay traveler characteristics clearly reflect the trip purposes of the previous table. The jobs in downtown San Francisco are typically in the high-paying professional, government and technical categories. The domination in those fields of white, male, college graduates is readily apparent. Even so, the homogeneity of the transbay traveler group compared to either the non-transbay BART user or the general population is remarkable. With 45% of current BART patronage from transbay travel, it is not surprising to hear accusations that BART serves the "privileged class."

4. Why Aren't More People Riding BART?

BART conducted a telephone survey in its service area in May 1973, before the Concord line opening, to determine the attitudes of potential patrons toward the rapid transit system. The report of the survey enumerates several reasons reported for non-use of BART.

Reasons For Not Using BART: (In order of frequency mentioned)

Have not had time to try it

Do not need to use it

Does not run weekends

Does not go where needed

Inconvenient from home

In the winter of 1973-74 (November-January), the BART Impact Program conducted a home interview survey in selected BART station areas in the East Bay. Household members who were employed full or part-time in the East Bay were asked if it would be possible for them to use BART for their regular work trip. 64% said it was impossible. Of these, 83.5% said this was because BART was too far from work, home, or both.

In the October 1974 survey of transbay travelers, travelers on all modes were asked to rate BART along several dimensions. All reported that they were least satisfied with BART's dependability of arriving on time and time spent waiting. There is certainly no quarrel with the accuracy of the traveling public's perception of BART's operational difficulties.

Figure 6

TRAVELER CHARACTERISTICS

Traveler Characteristic	Non- Transbay	October 1974 Transbay Traveler			BART District
	May 1974 BART User	BART	Bus	Auto	1970 Census
Sex (% Female)	49.2	31.0	46.0	28.0	51.8
Age (% 18-34)	59.5	52.0	49.0	46.0	35.0
Education (%4+ yrs College)	33.6	58.0	58.0	58.0	16.0
Income (% Over \$15,000)	41.6	62.0	54.0	61.0	29.3
Ethnicity (% White)	76.4	89.0	80.0	87.0	79.7

All of these attitudes and opinions reflect a combination of two factors: constraints on BART use due to its own (current) operational limitations, and constraints on BART use due to its nature as a regional trunk-line system. BART's current attempts to solve its equipment problems address only the first issue. A concerted effort by all public transit operators and their funding sources to more fully integrate local feeder/distribution service with the regional rail system is needed to solve the second issue.

5. What Can We Learn From BART At This Stage?

From even the limited current BART ridership, it is clear that BART can effectively serve a variety of trip needs, and can lure some motorists from their cars. It also has proven attractive to the middle- and upper-middle class, in contrast to formerly common beliefs that transit could not serve the psychological needs for prestige in modes of travel. While it is easy to say that it is too soon to judge BART, it is becoming evident that BART is not a panacea for the region's transportation ills, but rather is only one, highly specialized resource that must be diligently cultivated. If not, BART may never live up to its early, and perhaps in hindsight, overly optimistic promise.

III. IMPACT ON PUBLIC POLICY AND ATTITUDES

BART has been, for the past 15 years, an extremely topical subject for public debate, discussion and conjecture. The Bay Area's major daily newspapers have mined the apparently inexhaustible treasures of news emanating from the decisions of the BART Board, the controversies surrounding the design of stations, the location and undergrounding of the line, the progress (and delays in progress) of construction, the system cost over-runs and associated searches for additional funds, the opening of the system, the operational problems since opening, and the selection and de-selection of General Managers.

One result of this unusually high visibility is that practically every child in the Bay Area now recognizes the BART logo, and practically every adult is ready to launch into a debate about BART's merits and demerits at the drop of a hat. BART is known and recognized, cussed and discussed, an object of civic pride and scorn, hope and dismay.

Because of this exposure, there have been and continue to be changes in attitudes toward BART in particular, and transportation in general by Bay Area residents, and corresponding changes in policies adopted by public officials. This is an extremely important impact of BART, but one that is admittedly difficult to measure objectively. The analysis given here is not based on sound

statistical data or principles of social science, though such scientific analyses may be undertaken in due course; it simply represents the perceptions of a transportation planner who has "lived through" the BART experience.

Someone has said that the stages of a great project are:

- Enthusiasm
- Disillusionment
- Panic
- Search for the guilty
- Punishment of the innocent
- Reward to those who took no part

Many of the people who have been directly involved in the development of BART would probably agree that those six stages accurately portray the changes in public attitudes toward BART.

A somewhat less cynical view is that the changes in attitude have been mostly healthy, and necessary to develop a realistic approach to further transit development, and that the Bay Area will do a better job in the future as a direct result. These changes have been in both attitudes of individual citizens and policies of public bodies.

A. Attitudes of Individuals

Obviously, no two individuals or groups have precisely the same attitudes or changes in attitude over time; and further, the observations that follow are not based on survey data, or intended to be quantitatively precise. Qualitatively, however, the authors have recognized certain changes in attitude that appear to be common enough to be characterized as general:

1. Cynicism, Mistrust of "The System."

If there is any one fault of BART's initial management upon which all observers would agree, it is probably that of over-promising. Statements once made to the press and then unfulfilled for whatever reason have been capitalized upon by the press, usually with fairness and objectivity, but not always in any one newspaper, and almost never in some. As a direct result, many BART District voters openly express a sense of having been duped or misled and a corresponding cynicism about any statements by politicians in general.

2. Concern About Taxes

BART's costs, both capital and operating, have gone up, up, UP, along with everything else in our economy. This has been directly felt in the pocketbooks of citizens to

the point that few believe the voters would approve any new taxes for BART whatever, if they were asked on the ballot. This does represent a change in attitude from 1962 when the Bond Issue was approved, though it may not be too different from voter attitudes toward all types of taxes in the past few years.

3. Doubts About Technology

The people of the Bay Area were consistently promised a superior performance in BART because of "space-age technology." The dismal performance record of BART cars in terms of maintenance reliability, and the problems of automatic train control (though the latter are now well on the way to solution) have been well-publicized. Many people have begun to express skepticism about the ability of technology to make the kind of gains that our Sunday newspaper supplements routinely have promised us in the past. This may be a healthy "market adjustment," and is already being reflected in the greater questioning being given to PRT systems and other advanced technology concepts in other cities.

4. Pride in The System

Paradoxically, many of the same people who have come to doubt the technological promises of BART are proud of the technology which does work. The BART cars are attractive, inside and out; the stations and structures are pleasing to the eye; the ride is smooth, swift and comfortable. Many Bay Area residents love to take their visiting friends and relatives for a ride on BART.

5. Greater Interest in Transit

People who have been following the continuing saga of BART in their daily newspapers for 15 years necessarily have absorbed transit information, concepts and interest that they would not otherwise have gained. This is reflected in the general sense in the Bay Area that transit is a necessary part of the total transportation system, and shows up in such things as transit activism by the League of Women Voters and similar non-ideological public interest groups.

B. Public Policy

As individual attitudes have changed, so have the views of politicians at Federal, State and local levels, and these have started to be reflected in public policy actions. Not surprisingly, some of these policies parallel the individual attitudes already noted.

1. Public Candor

Because of the backlash from overpromising and optimism in the past, there is more of a willingness and desire by policy-makers to share the bad news, as well as the good news with the public, and somewhat less tendency to sugar-coat. Even more, the policy bodies are demanding straightforward reporting to them by their staffs, and are less likely to accept staff (or consultant) statements at face value without some digging.

2. Concern About Costs

The high capital costs of building an entire 71-mile rapid transit system at once has caught enough people's attention, from Washington to the Bay Area, that public policy now leans more strongly toward "low capital-intensive" systems and/or incremental approaches to capital project funding. BART's needs have also played a role in securing passage of both State and Federal bills for transit operations money.

3. Concern About Accountability

As BART began to have problems, the California Legislature expressed no little frustration with a BART Board that was appointed by local government officials, and thus, seemingly not accountable either to any one body, such as the Legislature, or to the voters. As a result, they passed a bill that effectively changed the BART Board to a directly-elected one. (At least one of the principal authors of that bill has since publicly stated that it was a "mistake," and that the appointed Board was less subject to political swings and thus more stable and responsible.) In any event, policy-makers doing more worrying about accountability is a refreshing change.

4. Interest in Transit Improvements

In part, at least, as a result of the presence of BART, city councils and other public agencies, such as airport operators, hospitals and universities, have taken a decidedly stronger interest in achieving new bus systems, not only to serve as feeders to BART stations, but to serve travel needs unmet by the auto, generally. Several medium-sized cities within the BART District that had repeatedly turned down transit service requests over the years, have recently approved sizeable tax increases to support bus systems.

In summation, the years of exposure to the perils of BART have had their impact upon the feelings of the Bay Area body politic. The net result may prove to have been the most positive early impact of the system!

IV. BART -- A SOUND INVESTMENT? ONE TENTATIVE AND PERSONAL VIEWPOINT

The authors are frequently asked by planners, engineers and other people who should know better, "Has BART proven to be a success?" Obviously, the answer to this question has to be dependent upon one's measure of success -- what criteria are used to judge -- and these criteria are various and contradictory, even among professionals. One of the approaches which the BART Impact Program will pursue is to measure BART's effects against the originally stated objectives of the BART planners, designers and policy-makers. This approach, however, will take time, not only because many of the impacts, such as those on land use, will probably be long-range in effect, but also because the system is not yet in full 20-hour, 7-day operation, at the headways originally envisioned.

A more practically significant -- perhaps the ultimate -- question about BART and its impacts was asked one of the authors by a representative of the Federal Office of Management and Budget: "If you had been in the position of saying 'yes' or 'no' to beginning the construction of BART in 1962, knowing what you now know, would you have given approval to go ahead?" Now, that is a question that can cause a person to really do some soul-searching, and that makes it difficult to indulge in semantic or academic fence-straddling.

It forces one to render a verdict, using all the information at hand, however incomplete. Subjectively, one must integrate all these pro's and con's, and give a personal judgment. The only qualifiers one can make are, first, that this judgment is based on the information now at hand, and that if new information is available in the future, one may reserve the right to change one's mind; and second, that it is a personal and partly subjective judgment. These, then, are the qualifications which the authors make in tackling that question.

With all that said, we can go on to give our answer to the question cited above, and simply stated, our answer is "yes." From the vantage point of hindsight we might do many things differently in carrying out the development of BART, but, yes, we would give our approval to go ahead. The obvious next question is "Why?," and we will attempt to answer that in three general categories.

A. BART As Part of a Plan Concept

As transportation planners we develop our ideas generally in the sequence of:

- Determination of transportation service level requirements ("Needs")
- Alternatives analysis

- Impacts analysis
- Cost-effectiveness analysis
- Financial plan-feasibility analysis

Without going into all the details of the Bay Area's regional transportation system, we can comfortably state that the original BART plan for a trunkline rapid transit system to serve major travel corridors in the Bay Area "feels" right to these planners on all the planning analysis levels listed above. This intuitive sense of the soundness of the plan concept is not in lieu of, but the result of, some hard-nosed analysis. It is, however, specific to the Bay Area, and it would be a mistake to attempt to superimpose the BART plan on any other urban area without going through similar hard-nosed analyses.

Some of the things that make the concept "right" for the Bay Area are:

1. Topography

The Bay Area is broken up by physical features -- the Bay, the coast range on the Peninsula south of San Francisco and in Marin County to the north, and the foothills in the East Bay. The effect of all these topographic constraints has been to channel urban development into fairly narrow bands and to severely constrain the major travel corridors -- onto bridges and tunnels, in some cases; and into narrow urban bands not susceptible to grid freeway development in other cases. Meeting travel requirements in these corridors without having to double-deck freeways leads strongly toward a rail transit type of solution.

2. Strong Centralization

In part because of the topographic constraints mentioned above and in part because of the continuing dominance of San Francisco and Oakland as commercial, financial, merchandising, shipping and cultural centers, the Bay Area has developed with dense clusters of multiple land uses. Low density, single-family suburban housing development has not been as rapid or all-pervasive as in some other urban areas, and has generally followed the natural corridors of the Bay Plain. This tendency to centralization has also lent strength to the plan for rapid transit linkages of the centers.

3. Choice and Diversity

It may be a truism to point out that San Francisco is not Des Moines or Paducah. The residents of the Bay Area

represent a diversity of lifestyles, viewpoints and cultural origins that is nearly unique, ranging from Oriental to European and from Middle American to Hip. One result is that here, perhaps more than in other communities, people want a choice, and that includes a choice of mode. The automobile, and even the automobile and the bus together, cannot satisfy the range of desires for personal mobility. To a large extent, people here are aware of the rapid transit service afforded to the people of New York, Toronto, Mexico City, Tokyo, London, Paris and Munich, and they are not uniformly content to do without that type of service.

4. Importance of the Spine

BART critics frequently point out that BART only carries a fraction of the Bay Area's total trips. This is true, especially now. The Bay Area freeways also carry only a fraction of total trips, but this in no way diminishes their importance as a part of the total system. Our highway system would be less effective if there were no freeways, even if all local roads and streets were superb. Conversely, a beautiful freeway system would be less useful if the local routes were all muddy, unpaved roads. Similarly, our transit system needs both a spine and connecting skeletal network.

Until BART, the Bay Area transit network consisted of a spotty mix of good local transit, poor local transit, and no local transit, with some transbay trunk buslines. With BART, we now have the start of a genuine transit spine on which we can build the bus systems that will comprise the rest of the skeleton. The physical presence of rail transit lines is a significant incentive.

B. BART As A Public Investment

While San Francisco newspapers are fond of referring to "the billion-dollar BART system" in terms intended to boggle the mind of those of us who can't even visualize a million dollars, it may yet turn out that the \$1.6 billion capital investment in BART was one of the shrewdest bargains the public has made. We say this with full recognition that BART has several years of stormy seas to sail through yet, including the probable need to totally rebuild or replace the present rolling stock in order to solve the maintenance and reliability problems. Including those costs -- which will probably be high -- the total capital costs of a 71-mile system with 34 stations will still be only a fraction of the cost of building far less ambitious systems in Washington, D. C., Atlanta, Baltimore, Denver, Miami and other U. S. cities.

Even with truncated versions of their original plans, some of those cities are now looking toward price tags closer to

\$10 billion, and the answer is not as simple as converting to constant dollars. In constant dollars, the Bay Area still got a bargain. This is even more remarkable when one realizes the pioneering in design and technology that had to be done by BART, and from which, presumably, the other systems will now benefit.

It appears that our timing was lucky indeed, avoiding all the inflationary pressures and critical shortages of the seventies. With all of BART's problems, electronic and mechanical, we still have a basic system -- tracks, ways, stations, power, yards, structures and a tube under the Bay, that taken together represent a superb civil engineering achievement.

And the price was reasonable. Lumping all the system's capital expenditures, including bond amortization, Federal dollars and Bay Bridge toll revenues (used to pay for the underwater tube), the cost works out to just over \$20 annual cost per capita for residents of the three BART counties for the 30-year life of the bonds. That is two tanks of gasoline in your family car.

C. Future Issues

Perhaps the most persuasive of the general categories of reasons why we say "yes" to the question, "Should BART have been built?" is that category of factors related to the future which, ironically, were not all foreseen in 1962, when BART began its course.

1. Energy Conservation

Enough debate and controversy has centered on this recently to satisfy our most masochistic tendencies, but it is clear that, at the very least, we need more options for travel in the future than the automobile patterns of the past have afforded. In the Bay Area, the physical presence of BART gives us some incentives and options that we would not otherwise have.

2. Environmental Conservation

The genuine concerns about preserving our resources, including land, air quality, open space, and water cut across transportation issues very directly in the Bay Area, not just as abstract concepts. BART's commitment provides a focus for the development and re-development of Bay Area cities that is clearly in the direction of less automobile-dependency, more centralization of land uses, and a better chance for preserving open space and the Bay. BART does not assure that all these things will happen -- it is only one factor among many, and there are strong pressures in the opposite direction. But BART seems likely to have an influence that would not be present otherwise, and some of us think it will be increasingly significant.

3. Cutback in Transportation Investments

We are entering a new era that increasingly looks like one of emphasis on making better use of the systems we have, and small, incremental capital investments to improve operations, as opposed to major capital investments to build whole new freeways or rapid transit systems. The present BART system, together with the existing Bay Area freeway and street system, provides us a base to work from that we believe will be the envy of many other communities.

If all of the above sounds too strongly optimistic, the authors would hasten to add assurances that they are well aware of the counter-arguments, which are persuasive, and only alluded to here. But ultimately, in making those subjective tradeoffs, these represented the key factors that weighed in favor of our simple "yes" answer to the BART decision. Only time will tell us more. We will all be watching attentively.

* * * * *

It should be stated that the viewpoints expressed here are exclusively those of the authors, and do not necessarily represent the conclusions or policies of the BART Impact Program, its Federal funding agencies, the Metropolitan Transportation Commission, the State of California or the Bay Area Rapid Transit District. We alone are responsible for this paper and its judgments.

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